

Nov. 1892. *Dr. Common, On the Best Form of Mounting etc.* 19

Now, in Professor Newcomb's "Investigation of Corrections to Hansen's Tables de la Lune," 1876, he gives for—

$$1861 \quad \delta\varpi = +2''.2$$

and

$$1868 \quad \delta\theta = +4.5$$

Comparing this with my own determination, I have arrived at the following corrections to the motions of the perigee and node, in which T represents as before the number of centuries from the epoch 1800 :—

$$\delta\varpi = -0''.9 + 5''.09 T$$

and

$$\delta\theta = +30.75 - 38.6 T$$

I have confined myself entirely to modern observations, as the problem of the secular acceleration of the Moon's mean motion is in a very unsettled state. What is aimed at by astronomers is to obtain a constant coefficient progressing according to the square of the time, and this they will never obtain for any great length of time, as the very causes which give rise to this acceleration are not of a constant nature.

*Aberlemno, Forfarshire :*  
1892 August 30.

---

*On the Best Form of Mounting for a Large Reflector.*  
By A. A. Common, LL.D., F.R.S.

A silver on glass mirror of eight or nine feet aperture seems now to be possible, and it becomes worth while to consider the best way to mount such a mirror for astronomical purposes.

Opinions will differ as to the optical arrangements most suitable, but the Newtonian form seems, in my opinion, to be the best, for many reasons that it is not necessary to go into now.

The best use of such an enormous telescope would probably be to explore and discover, and this would naturally be best done by using it as a visual telescope, for which purpose a focal length of about twelve times the aperture would perhaps be most suitable, giving for the smaller mirror above mentioned some ninety-six feet focal length.

To mount such a telescope equatorially and put a dome over it in the usual way would be a most costly undertaking, and even if the money were available it is very doubtful if any form of equatoreal would be the most suitable. The difficulty of providing access to the eye end for the observer, and of following the movement, especially when we remember that off the

C 2

meridian the upper part of the tube must be rotated, is one not easily got over.

The equatorial movement is necessary for photographic and spectroscopic work, but here a very much shorter focal length can be advantageously used. For visual work it is undoubtedly the best, but it may be obtained at such a sacrifice of advantages that could otherwise be obtained, that it might be worth while giving up the one for the others.

The chief consideration in designing a mounting for such an immense telescope would be to keep the cost as low as possible; the first thing, therefore, is to give up the equatorial mounting, with its expensive and heavy work, and adopt some kind of altazimuth mounting. We have had large reflectors mounted in this manner. The plan used by Sir William Herschel in mounting his four-foot is typical. For the work of exploration it answers admirably, and the observer is provided with a fairly safe position. There are, however, many objections, such as the close tube, the absence of protection from the wind and rain, and the want of perfect protection and comfort for the observer. Keeping in mind the requirements that experience has shown to be important in designing a reflecting telescope, particularly the use of a skeleton tube instead of a close one, easy access to the mirror for covering or removal, movement in one plane only, &c., and endeavouring to get the very best possible conditions for the observer, I have been led to devise a form of mounting that does certainly offer every advantage that I could wish, excepting that of equatorial motion. The facilities for movement in both directions are so great that I have not any doubt that an apparatus could be designed that would work well enough to keep the object under examination in the field of view in a sufficiently steady manner.

I would take as a basis for the mounting of the telescope that form designed by the late Dr. Draper, and described by him in his paper "On the Construction and Use of a Silvered Glass Telescope," published by the Smithsonian Institution. (The earliest account of a mounting on this principle that I know is in Smyth's *Celestial Cycle*, vol. ii., page 540; this is Miss Herschel's telescope, made probably by Sir William Herschel.) This form of mounting is, no doubt, so well known that it is hardly necessary to do more than mention that the telescope is hung by one end on trunnions, the eye end being in one of them, which is made hollow for the purpose. The counterpoising of the free end of tube with mirror attached is effected by weights carried at the ends of rods supported at their lower ends and connected with the tube by iron wire ropes. The square framework carrying the tube and counterpoises revolves on a central pin, so the eye end is carried round in a circle of about the diameter of the focal length. I would use such a framework as this, but double the length, with the telescope in one half and the counterpoise weights in the other. The centre

of motion I would place exactly under and midway between the trunnions, the eye-piece end being about five feet from the centre of motion, causing a necessary movement of the observer of at the most 30 inches per hour.

Instead of a tube connecting the mirrors it would only be necessary to have two lattice girders braced together at the top and bottom. For a few feet near the trunnions a tube would be needed, but instead of putting any more tube I would enclose the framework containing the mirrors entirely, making it a large dark chamber, the connection being made at the trunnion end by a flexible material.

The square framework carrying the dark chamber which forms the telescope and the counterpoise weights in the other side would rotate on a central vertical pin, the greater part of the weight being taken off by floating a suitable circular tank in water; the mirror end of the two lattice girders could slide along an arc of a circle, so that by suitable gearing an end movement could be given in altitude, a similar movement in azimuth being obtained at the edge of the circular tank. We should thus have a complete telescope capable of being pointed to any part of the heavens.

To shelter this from the wind and weather, and to support the observer, I would enclose the whole in a framework covered with any suitable material, and of such a shape as to come close up to the upper end of the tube near the trunnions, where the chamber in which the observer could sit, would be placed. The whole of this outer framework would run on a circular railway, and could be made sufficiently wide to provide for two or three hours' continuous movement of the contained telescope without any alterations, the only opening being a flap shutter at an angle of  $45^\circ$ , covering the open end of the telescope when not in use.

Access would be obtained for the observers by suitable stairs on the outer framework, which, being entirely detached from the inner telescope, would not affect it.

There are many matters of detail which would have to be worked out, but it will be found that the form of mounting I have indicated here is one that offers many advantages, particularly as regards the question of cost, while it provides for the safety and comfort of the observer absolutely.

There are two modifications in this form that are worth consideration—the first, that the second part of the frame carrying the counterpoise weights in the above-mentioned plan might be dispensed with, as well as the covering of inner framework, counterpoising it by weights in the floating tank. This would reduce by nearly one-half the size of the outer covering, but it would be attended with this disadvantage: the wind would have enormous power in the outer covering, as the centre of rotation would be near one end. The other modification is to have the framework containing the telescope rotating exactly on the same plan as Dr. Draper's, and enclose the whole in a fixed circular house

similar to his, with a provision for carrying the observer similar in general character to his, making it, in fact, exactly on the lines he has laid down.

The first modification would, perhaps, be the best form altogether, as the sides and ends of the outer house could be made with a considerable slope, so as to reduce the upsetting power of the wind. This would retain the important position of the observer as close as possible to the centre of motion of the telescope.

---

*Probable Error of the Clock Correction when both the Clock Rate and the Instrumental Constants are found by a Least Squares Solution of a Single Night's Observations.* By the Rev. John T. Hedrick, S.J.

(Communicated by the Rev. W. Sidgreaves, S.J.)

It seems to be a common practice in the comparison of time determinations, as in longitude work, to give a constant probable error for the clock correction of each night and to combine the different nights' work according to these probable errors. This is equivalent to taking the clock rate as known perfectly, whereas its value has also its degree of uncertainty, making the probable error of the clock correction quite different for different moments. Of course, if the time comparison takes place during the period of observation, and especially if about its middle, there will be less objection to the method.

A reason for this neglect of the probable error of the clock rate may be the difficulty of determining it when another quite common practice is followed of determining the clock rate from the comparison of the clock corrections found from night to night. If results are expected of sufficient accuracy to make it worth while taking account of probable errors, this practice seems hardly defensible for observations made with portable instruments. For we are likely to have periodic or irregular fluctuations of rate in a clock, not of the best, exposed to receiving injurious shocks in carriage, and not set up so as to be thoroughly protected against the effects of change of temperature, or even against instability in the clock pier. Whatever periodic or accidental errors may exist in the star places of the various modern ephemerides, they are so small that, except in a fixed observatory, the proper method is to find the clock rate each night from that night's observations.

Supposing that a least squares solution of the night's work is thought worth the while, there is still a difficulty in getting *the general expression for the probable error of the clock correction at any moment.* Its probable error at a given moment may be found by making this moment the epoch of the constant part of the total clock correction; but this may bring in practical diffi-